ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Part 15 of the Commission's Rules to Allow Certification of Equipment in the 24.05 to 24.25 GHz Band at Field Strengths up to 2500 mV/m	)	**ET Docket No. 98-156**

To: The Commission

COMMENTS OF THE AMERICAN RADIO RELAY LEAGUE, INCORPORATED

The American Radio Relay League, Incorporated (the League), the national association of amateur radio operators, by counsel, hereby respectfully submits its comments in response to the *Notice of Proposed Rule Making* (the Notice), FCC 98-156, released September 1, 1998. This proceeding is based on a petition for Rule Making, RM-9189 filed by Sierra Digital Communications, Inc. (Sierra), on which the League has previously filed comments. The instant Notice would amend Part 15 of the Commission's Rules governing unlicensed radio frequency (RF) devices, in order to permit the use of fixed, point-to-point transmitters in the 24.05-24.25 GHz band at field strengths up to 2.5 volts per meter, measured at 3 meters. In continued strenuous opposition to the Notice proposal, the League states as follows:

1. The League argued in response to the Sierra rulemaking petition that the high-power[1]

[1] While the transmitter power of the devices would be approximately one milliwatt, the antenna gain in the main beamwidth of the antenna renders the ERP of the transmissions in that direction exceptionally high for Part 15 specification. Sierra has attempted to claim that the power levels proposed in its petition are less than those permitted in the 5 GHz band for Part (continued...)

Part 15 devices now proposed by the Commission to be permitted at 24.05-24.25 GHz, is entirely inappropriate for Part 15 unlicensed facilities. Indeed, the Commission has previously held exactly such. In 1980, M/A-Com petitioned the Commission to amend Part 15 to accommodate the operation of low power microwave radio systems in the 24.05 to 24.25 GHz band. The Commission afforded that petition a file number (RM-3678), and considered it together with a related Part 94 proceeding (Docket No. 79-337) dealing with low power facilities in the 22-23 GHz band. In its *Further Notice of Proposed Rule Making*, the Commission stated as follows:

> The Commission feels that there is merit in providing spectrum for a low power, non-frequency coordinated radio operation in the 22 to 24 GHz band. It is felt that these devices can meet certain needs for low cost, short-distance video, voice and data communications without the burden and expense of frequency coordination. These devices are envisioned to be highly directional and to have limited (short-range) interference potential. In addition, the devices are readily movable should interference be encountered. However, the Commission feels that such operations are not Part 15 in nature as proposed in RM-3678 and that some form of licensing is appropriate (footnote omitted).
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> (*Id.*, FCC 80-486, 45 Fed. Reg. 55775, released August 19, 1980).

2. The Commission decided not to propose the unlicensed Part 15 operation requested by M/A-Com. However, M/A-Com petitioned for reconsideration, and in 1983, the Commission upheld the earlier decision not to permit unlicensed, uncoordinated point-to-point microwave operation in the 24 GHz band:

> In the FNPRM, the Commission asked for public comment on questions concerning the need for frequency coordination and licensing for the lower power

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[1] (...continued)
15 devices with unlimited antenna gain. However, those transmissions are spread-spectrum transmissions, and not narrowband transmissions. The comparison is therefore spurious and inapplicable.

> service and on the appropriate technical standards. We stated that we saw merit in providing spectrum for non-frequency coordinated operations in the 22 to 24 GHz band because these low power devices were envisioned to be highly directional and to have limited (short-range) interference potential. Thus, we proposed to eliminate the coordination requirement for the channel pair 21.825/23.025 GHz (footnote omitted) except within 25 kilometers of the Canadian and Mexican borders. We also proposed to apply the same technical standards set forth for the other low power devices to this channel pair. Furthermore, we stated that some form of licensing seems appropriate because these low power microwave operations do not fall within Part 15 of the rules. However, we posed questions on these points...
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> ******
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> We do not find that it is appropriate to introduce a non-frequency coordinated, unlicensed communications service into the 24 GHz band. The band is allocated on a primary basis for Federal Government radiolocation use and on a secondary basis for non-Government radiolocation and Amateur use, as well as for Industrial, Scientific and Medical Service (ISM) equipment. The frequencies are already being used by radar devices, and NTIA has recommended that the operations proposed by M/A-Com not be permitted in the 24 GHz band because they would be inconsistent with the current allocated use of the band (citation of NTIA correspondence omitted). We are, therefore, not adopting rules authorizing low power microwave operations in the 24 GHz band.
>
> *Second Report and Order*, 53 RR 2d 1676, at 1677-78 (1983)

3. Therefore, it is obvious that the Commission has previously considered the exact same proposal now advanced, and at that time realized that licensing was necessary for such devices; no unlicensed operation was permitted at 24 GHz, due to interference potential. Nothing in the instant Notice states a reason for the complete departure from past precedent. The earlier proposal was rejected after full notice and comment rulemaking. Given the foregoing, the League requests that the Commission not proceed with the Notice proposal.

4. The Notice first cites Sierra's faulty argument that because field disturbance sensors in the center portion of this same band[2] are permitted at field strengths up to 2500 mV/m, point-to-point operations should be permitted at that same maximum field strength. Those devices are not even remotely comparable to the interference characteristics of a point-to-point microwave system using 33 dBi gain antennas. The decay factor of signals from field disturbance sensors is extremely high (intentionally so), and those devices have therefore a far lower interference potential to licensed services due to limited range. By contrast, a high-power, high gain antenna, point-to-point device has an interference contour in the main antenna lobe that stretches for many miles. Field disturbance sensors are also restricted in operating range to a few meters, and often operate well below the authorized power levels. Many are used in anti-collision applications where the interference potential would be transitory, as vehicles pass in and out of the reception range of an affected receiver. Field disturbance sensors are also located near ground level where long-distance propagation would be unlikely. As well, it would appear that there has not been to date significant deployment of FDS devices, minimizing the likelihood that amateurs would have encountered them. The comparison to field disturbance sensors in the instant Notice is therefore specious for a number of reasons.

5. Furthermore, a field disturbance sensor is not a communications device with a long path length. The Commission notes that the proposed high-power Part 15 devices are specifically intended to be a substitute for licensed point-to-point microwave facilities. Licensed facilities

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[2] Such devices may operate at 24.075-24.175 GHz with field strengths up to 2500 mV/m. Other Part 15 devices, however, are limited to 250 mV/m. The obvious reason for this is the lower interference potential from field disturbance sensors than for other devices with more efficient antenna systems.

under part 101 of the Commission's Rules are required to be licensed and coordinated for a reason; they have the potential for interfering with other facilities. The "costs and delays" claimed by Sierra and the Commission in coordinating and obtaining a Part 101 point-to-point microwave license are unspecified and frankly, insignificant. Undersigned counsel, for example, was recently able to license a new Part 101 point-to-point microwave facility within 30 days of submitting an application, and was further able to obtain authorization to place the new facility on the air within five days of frequency coordination, by special temporary authority. The suggestion that high-power point-to-point use of Part 15 devices is necessitated by costs and delays inherent in coordination and licensing of licensed Part 101 facilities is simply false.

6. Even if there was some impracticality in obtaining licenses for point-to-point microwave facilities, the Commission is without jurisdiction to allow point-to-point microwave devices, which have significant interference potential to licensed services in the same band,[3] to operate on an unlicensed basis. Part 15 devices have no allocation status, internationally or domestically. These devices are permitted on an "at-sufferance" basis: they must not cause any interference to licensed radio services, and they must tolerate interference received from licensed radio services in the same bands. The Communications Act of 1934 is devoid of any authority to allow unlicensed devices with substantial interference potential; such devices must be licensed. The only authority to permit unlicensed devices under the Act is with respect to radio control

[3] The Notice refers to increased interference to licensed users from the instant proposal. That is not the proper test. Radio transmitters that are capable of interfering with licensed services cannot operate without a license pursuant to the Communications Act. The Commission cannot allow such devices to be operated on an unlicensed basis; it has no jurisdiction to do so.

and citizen's radio service facilities, 47 U.S.C. §307(e),[4] and for the Commission to regulate the interference potential of RF devices by "reasonable regulation", 47 U.S.C. §302. This, the Commission has done by permitting operation of such devices in bands allocated, on a primary basis, to one or more licensed radio services, but only where the operation of the unlicensed devices has been determined to be unlikely to cause interference to the licensed radio services. The Commission cannot authorize these devices without a license, merely because interference potential outside the main lobe of the antenna is less than that in the boresight of the antenna.

7. The next inapplicable justification cited in the Notice is Sierra's claim that narrowband point-to-point unlicensed devices should be permitted at high power and antenna gain because spread-spectrum systems operating in other bands are permitted to use high gain antennas under Part 15, provided that there is a reduction in transmitter output power for incremental increases in antenna gain above 6 dBi. Section 15.247 spread spectrum systems, however, innately have significantly less interference potential than do narrowband Part 15 systems, which is exactly why the relaxed regulations under that rule section are unique to Spread Spectrum Part 15 devices in the first place. The Notice cites the use of spread spectrum point-to-point links for certain emergency and public safety applications, but the interference potential of such devices precludes any justification therefrom for the devices proposed to be authorized in the Notice. With spread spectrum systems, the spreading reduces the power density of the signal at any

[4] The Telecommunications Act of 1996, Pub. L. 104-104, 110 Stat. 56, Feb. 8, 1996, amended Section 307(e) of the Communications Act of 1934 to add to those services which may by FCC rule operate without individual licenses the aviation radio service for aircraft stations operated on domestic flights when such aircraft are not otherwise required to carry a radio station; and the maritime radio service for ship stations navigated on domestic voyages when such ships are not otherwise required to carry a radio station.

frequency within the transmitted bandwidth, thereby reducing the probability of causing interference to other signals occupying the same spectrum. This factor is not present with narrowband systems such as those proposed in this proceeding. As such, their potential for interference is a unique consideration, and has no application to high-powered, narrowband Part 15 devices.

8. The Commission states at paragraph 7 of the Notice that allowing these devices will offer "flexibility" and will allow users to avoid "costs and delays in obtaining licenses," and that it does not perceive a difference in interference potential between field disturbance sensors and high-gain, point- to-point devices operating in the same bands. It seeks comment on these tentative conclusions. As discussed above, the difference in interference potential of these devices (and their intended communications ranges) is that of night and day: the operation of field disturbance sensors, and their interference contours, are closely circumscribed. Point-to-point microwave facilities, operated over long paths, from high locations (the same locations at which terrestrial amateur stations are typically operated) have a far greater potential for interference to amateur stations than do field disturbance sensors. The Commission has made numerous accommodations for the type of communications proposed herein; it has authorized such devices to operate on a licensed basis under Part 101; it has permitted the same services to be provided by U-NII and U-PCS devices and spread-spectrum devices; and it has permitted the same services to be provided in the millimeter wave bands above 40 GHz. The Commission in this Notice, however, discounts the perfectly reasonable, existing, low-cost or similar cost alternatives for providing exactly the same services that would be provided by the instant

proposal, by simply saying that it "makes no judgment" concerning these alternatives[5]. The Commission must, however, conduct a thorough and complete analysis of available, more compatible alternatives. It is only by such an analysis that the Commission can justify the action it proposes. This is especially true in this case, where (1) there is a large allocation for licensed point-to-point microwave facilities, and (2) the proposed authorization would expand the concept of Part 15 unlicensed operation beyond its statutory boundaries. The Commission's failure to determine the necessity of this action based on available alternatives renders the Notice proposal defective.

9. Perhaps the most arbitrary of the Commission's determinations is the suggestion at Paragraph 10 of the Notice that, on the one hand, the League's comments on the Sierra petition "had not demonstrated that there will be a significant risk of interference to Amateur operations in the 24.05-24.25 GHz band segment", but, at Paragraph 11, it is "concerned that Amateur Satellite operations in the 24.00-24.05 GHz band segment will be relying on the reception of weak signals." It is absolutely true that amateur satellite operation, especially the new Phase 3D satellite, necessitates use of extremely sensitive receivers. However, there is a substantial amount of terrestrial amateur weak-signal activity at 24 GHz, most of which is centered at 24.192 GHz, which utilizes the same sensitive receivers.[6] This microwave band, and the 10 GHz band, are

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[5] The availability of alternatives to what would be an *ultra vires* act by the Commission in expanding the concept of unlicensed transmitters is an abdication of its responsibility under the Communications Act. Not only are alternatives to the proposed action an important consideration that the Notice merely sidesteps; they provide an alternative to creating interference to licensed radio services.

[6] In any case, should the Commission adopt the Notice proposal (which clearly it should not) it must require that these devices avoid frequencies between 24.00-24.05 GHz and 24.190-24.195 GHz.

the two most heavily-utilized amateur microwave bands above 2.5 GHz, and they accommodate a significant amount of experimentation, and a significant amount of investment by amateurs in equipment. Currently, there is a substantial amount of literature on the subject of 24 GHz Earth-moon-Earth (EME) experimentation, which necessitates low noise levels.[7] Amateur operation of various types is subject to substantial interference from the proposed Part 15 devices.[8]

10. The Commission, in preliminarily concluding that there will not be significant interference from these devices, takes much comfort from the fact that the devices will use "relatively low power" and directional antennas and will be operated in fixed configuration, so that the source of any interference could be relatively easily determined. There is no comfort to be obtained from any of these factors. First, as discussed above, this is not relatively low power at this frequency. Field strength of 2.5 volts per meter is significant power, and when the point-to-point transmitters are operated at high elevations to permit long path lengths, the interference potential is significant. Second, as to the use of directional antennas (the proposed rules stipulate a minimum antenna gain of 33 dB), to localize interference in one direction, interference in the main lobe of the antenna is exacerbated because the interference contour in that direction is expanded. Furthermore, the Notice says nothing about antenna sidelobes. Minimum antenna performance, such as 12 dB on the first sidelobe and 18-20 dB on the second,

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[7] Typical amateur receivers that operate in this band utilize a 3 to 4 dB noise figure, though in theory, preamplifiers have a theoretical noise figure of 2 to 3 dB. These receivers are operated in conjunction with transmitters that typically transmit at 50 mW.

[8] See the attached, draft reference circuits for amateur equipment operating in this band. As can be seen, the configuration of amateur stations would subject them to significant interference from the proposed devices. Amateur communications are conducted at typical ranges of up to 40 miles.

would be necessary in any case if such facilities are permitted. Third, while interference from fixed narrowband devices with directional antennas may be a simple matter to identify, the adversely affected radio amateur has little practical recourse thereafter. Surely enough, these devices must cease operation in the event of interference according to the rules. However, the Commission cannot be relied upon for any enforcement assistance in such matters whatsoever, especially since the interference is not to safety of life type communications. The radio amateur cannot be expected to obtain voluntary compliance from the unlicensed operator of the interfering transmitter, and therefore must suffer continued interference. Interference from these devices, once established, stands little chance indeed of being remedied. It is unfair for the Commission to utilize, as a justification for allowing an incompatible use in an allocated band, the ability of the victim service to identify interference, when it has no intention or ability to remedy the interference when it occurs.

11. Finally, the Commission claims that amateurs should suffer no more interference from point-to-point Part 15 devices than from Industrial, Scientific and Medical (ISM) equipment which may operate in the same frequency range without radiated emissions limits. Again, ISM devices have no long path lengths; ISM devices are not operated from high elevations; the noise from ISM devices has a rapid decay at distance; and ISM devices are generally not located at elevations where amateur 24 GHz stations are located (but where point-to-point unlicensed microwave facilities are likely to be found).

12. In summary, the Commission has stated absolutely no basis for its conclusion that there will not be significant interference to the Amateur Service from 2.5 volt-per-meter directional signals from point-to-point unlicensed microwave facilities at 24 GHz. It simply

draws its conclusion without stating any facts, or conducting any analysis, that would justify such. The Commission is correct that allowing these devices in the Amateur-Satellite segment at 24.00-24.05 GHz would disrupt amateur-satellite communications, but the same rationale for protecting those communications applies to other amateur weak-signal communications, especially that centered at 24.192 GHz. The League attaches hereto some basic reference circuits for amateur stations that operate in this band, to establish the level of interference protection it, as a licensed service that must be protected from interference, requires. It is obvious that there are substantial interference contours created by the proposed Part 15 devices, and there has not been stated any means of avoiding interference, or resolving it when it is experienced. The proposed operation cannot be legally permitted on an unlicensed basis, as it expands the concept of Part 15 operation far beyond what the Communications Act can allow. The Commission has already made this specific finding, and nothing has changed since then that would allow the instant, unreasoned departure from prior precedent.

13. Should the Commission permit these devices notwithstanding the foregoing, which the League contends it should not, it would have to, at least, require any manufacturer of such devices to maintain a record of purchasers, location of facilities, frequencies, emissions, bandwidths, path lengths and azimuths, antenna gain and height, and to furnish these lists periodically to the League, to be made available to radio amateurs for coordination purposes. Those manufacturers would also have to be required to cause the frequency of the device to be changed in order to resolve interference incidents when experienced, or to terminate the path where the interference cannot be resolved. Any action in this proceeding should be suspended until such time as the manufacturers of these devices develop spectrum etiquette plans acceptable

to the League. Finally, the Commission must provide firm assurance that it will immediately, upon complaints of actual interference that cannot be resolved rapidly by contacting the operator of the device, order the manufacturer of the device, and its operator, to cause operation to cease without delay, until all interference to the Amateur Service is resolved to the satisfaction of the Amateur licensee.

Respectfully submitted,

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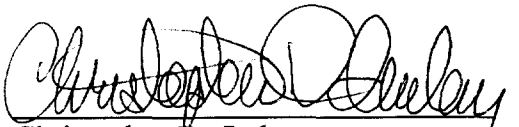
By: 
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APPENDIX A
STANDARD REFERENCE CIRCUITS FOR AMATEUR STATIONS OPERATING AT 24 GHZ

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High End 1.2 cm SSB Amateur Station

The high-end SSB amateur station communicates with other SSB/CW stations using troposcatter.

Characteristics	Values	
Frequency Band (MHz)	24,000-24,250	
Channel Spacing	Random	
Information Rate	Speech	
Emission Type(s)	2K50J3E	
Transmitter Power (dBW)	-10	
Transmission Line Loss (dB)	Transmit: 0.5	Receive: 0.5
Antenna Polarization	Horizontal	
Antenna Maximum Gain (dBi)	40	
Maximum e.i.r.p. (dBW)	29.5	
Receiver IF Bandwidth	SSB:2500 Hz CW:100 Hz	
Receiver Noise Figure (dB)	4	
Receiver Thermal Noise (dBW)	-165 (290 Kelvin background) -179 (CW)	
Receiver Signal-to-Noise Ratio (dB)	+6	
Maximum Long-Term Interference Power [dB(W/Hz)]	To be determined	
Maximum Path Length (km)	Depends on propagation mode	

Typical 1.2 cm SSB Amateur Station

The typical SSB amateur station communicates with other SSB/CW stations using troposcatter.

Characteristics	Values	
Frequency Band (MHz)	24,000-24,250	
Channel Spacing	Random	
Information Rate	Speech	
Emission Type(s)	2K50J3E	
Transmitter Power (dBW)	-33	
Transmission Line Loss (dB)	Transmit: 0.5	Receive: 0.5
Antenna Polarization	Horizontal	
Antenna Maximum Gain (dBi)	34	
Maximum e.i.r.p. (dBW)	0.5	
Receiver IF Bandwidth	SSB:2500 Hz CW:100Hz	
Receiver Noise Figure (dB)	12	
Receiver Thermal Noise (dBW)	-157 (290 Kelvin background) -171 (CW)	
Receiver Signal-to-Noise Ratio (dB)	+6	
Maximum Long-Term Interference Power [dB(W/Hz)]	To be determined	
Maximum Path Length (km)	Depends on propagation mode	

High-End 1.2 cm CW Amateur Station

The High-End CW amateur station communicates with other stations using troposcatter.

Characteristics	Values	
Frequency Band (MHz)	24,000-24,250	
Channel Spacing	Random	
Information Rate	10 bit/s	
Emission Type(s)	100HA1A	
Transmitter Power (dBW)	-10	
Transmission Line Loss (dB)	Transmit: 1	Receive: 0

Antenna Polarization	Horizontal
Antenna Maximum Gain (dBi)	40
Maximum e.i.r.p. (dBW)	29.5
Receiver IF Bandwidth	CW:100Hz SSB:2500 Hz
Receiver Noise Figure (dB)	4
Receiver Thermal Noise (dBW)	-179 (290 Kelvin background) -165 (SSB)
Receiver Signal-to-Noise Ratio (dB)	+1
Maximum Long-Term Interference Power [dB(W/Hz)]	To be determined
Maximum Path Length (km)	Depends on propgation mode

Typical 1.2 cm CW Amateur Station

The typical CW amateur station communicates with other stations using troposcatter.

Characteristics	Values
Frequency Band (MHz)	24,000-24.250
Channel Spacing	Random
Information Rate	10 bit/s
Emission Type(s)	100HA1A
Transmitter Power (dBW)	-33
Transmission Line Loss (dB)	Transmit: 0.5 Receive: 0.5
Antenna Polarization	Horizontal
Antenna Maximum Gain (dBi)	34
Maximum e.i.r.p. (dBW)	0.5
Receiver IF Bandwidth	CW:100Hz SSB:2500 Hz
Receiver Noise Figure (dB)	12
Receiver Thermal Noise (dBW)	-171 (290 Kelvin background) -157 for SSB
Receiver Signal-to-Noise Ratio (dB)	+1
Maximum Long-Term Interference Power [dB(W/Hz)]	To be determined
Maximum Path Length (km)	Depends on the propagation mode

Note: CW is often necessary on transmit to extend the range at this power level.

Typical 1.2 cm SSB Satellite Amateur Station

Characteristics	Values
Frequency Band (MHz)	24,000-24,050
Channel Spacing	Random
Information Rate	Speech
Emission Type(s)	2K50J3E
Transmitter Power (dBW)	
Transmission Line Loss (dB)	Receive: 0.5
Antenna Polarization	RHCP
Antenna Maximum Gain (dBi)	40
Maximum e.i.r.p. (dBW)	
Receiver IF Bandwidth	2500 Hz
Receiver Noise Figure (dB)	4
Receiver Thermal Noise (dBW)	-167 (30 Kelvin background)
Receiver Signal-to-Noise Ratio (dB)	+6
Maximum Long-Term Interference Power [dB(W/Hz)]	To be determined
Maximum Path Length (km)	45,000km

Note:there aren't any planned satellites that will use a 10 GHz uplink.

Typical 1.2 cm CW Satellite Amateur Station

Characteristics	Values
Frequency Band (MHz)	24,000-24.050
Channel Spacing	Random
Information Rate	10 bit/s
Emission Type(s)	100HA1A
Transmitter Power (dBW)	
Transmission Line Loss (dB)	Receive:0.5
Antenna Polarization	RHCP, Horizontal, or Vertical
Antenna Maximum Gain (dBi)	40
Maximum e.i.r.p. (dBW)	
Receiver IF Bandwidth	100 Hz
Receiver Noise Figure (dB)	4
Receiver Thermal Noise (dBW)	-181 (30 Kelvin background)
Receiver Signal-to-Noise Ratio (dB)	+1
Maximum Long-Term Interference Power [dB(W/Hz)]	To be determined
Maximum Path Length (km)	45,000km

Typical 1.2 cm WBFM Amateur Station

The typical FM voice station can communicate with other FM voice amateur stations.

Characteristics	Values
Frequency Band (MHz)	24,000-24,250
Channel Spacing	Random
Information Rate	Speech
Emission Type(s)	200K0F3E
Transmitter Power (dBW)	-13
Transmission Line Loss (dB)	Transmit: 0 Receive: 0
Antenna Polarization	Vertical
Antenna Maximum Gain (dBi)	40
Maximum e.i.r.p. (dBW)	27
Receiver IF Bandwidth	200kHz
Receiver Noise Figure (dB)	12
Receiver Thermal Noise (dBW)	-138 (290 Kelvin background)
Receiver Signal-to-Noise Ratio (dB)	+10
Maximum Long-Term Interference Power [dB(W/Hz)]	To be determined
Maximum Path Length (km)	Depends on propagation mode

Typical 1.2 cm AM ATV Amateur Station

The typical AM ATV station communicates with other ATV stations and repeaters using LOS modes.

Characteristics	Values
Frequency Band (MHz)	24,000-24,250
Channel Spacing	6 MHz
Information Rate	Fast scan video
Emission Type(s)	visual 5M25C3F Aural 36K0F3E
Transmitter Power (dBW)	-13
Transmission Line Loss (dB)	Transmit: 0 Receive: 0
Antenna Polarization	Horizontal

Antenna Maximum Gain (dBi)	40
Maximum e.i.r.p. (dBW)	27
Receiver IF Bandwidth	4.2 MHz
Receiver Noise Figure (dB)	12
Receiver Thermal Noise (dBW)	-124 (290 kelvin background)
Receiver Signal-to-Noise Ratio (dB)	35 dB (4 dB for marginal contacts)
Maximum Long-Term Interference Power [dB(W/Hz)]	To be determined
Maximum Path Length (km)	line of sight

Typical 1.2 cm Packet Amateur Station

Packet stations are typically used for point to point links on this band.

Characteristics	Values
Frequency Band (MHz)	24,000-24,250
Channel Spacing	random
Information Rate	2Mb/s
Emission Type(s)	2M5F3E
Transmitter Power (dBW)	-20
Transmission Line Loss (dB)	Transmit: 0 Receive: 0
Antenna Polarization	Horizontal
Antenna Maximum Gain (dBi)	40
Maximum e.i.r.p. (dBW)	20
Receiver IF Bandwidth	2.5 MHz
Receiver Noise Figure (dB)	12 dB
Receiver Thermal Noise (dBW)	-127 (290 Kelvin background)
Receiver Signal-to-Noise Ratio (dB)	15
Maximum Long-Term Interference Power [dB(W/Hz)]	To be determined
Maximum Path Length (km)	line of sight